MEASURMENT OF STRAP FORCES IN BACKPACKS

MOTIVATION

During the evaluation of mechanical comfort while pressure distribution measurements of backpacks, constant control of the strap force output (Fig. 1) is needed. To date no monitoring system is commercially available.

CHALLENGE AND PURPOSE

Develop a mobile (wireless) prototype (Fig. 2) for acquiring strap forces in backpacks for the shoulder, chest and pelvic straps. Achieve Proof of Concept (PoC).

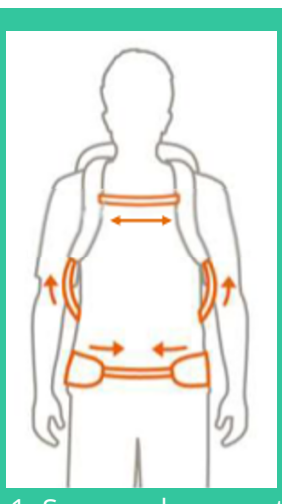
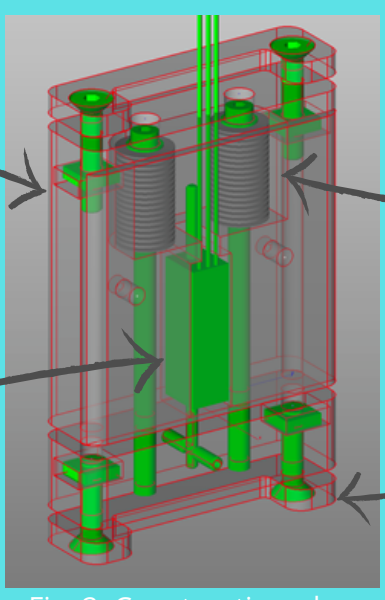


Fig. 1: Sensor placements to measure the strap forces

DESIGN

Shell
- Rapid prototyping FDM
- Lightweight

Measurement principle
- Detect change of resistance (potentiometer)



Disc springs
- Serial and parallel for forces of 25-150 N
- Act as counterforce

Fixation
- U-shaped metal brackets
- Even distribution of loads

Fig. 2: Construction plan

MEASUREMENTS

Static calibration
- free-hanging sensor
- weights added according to sensor type (shoulder, chest, pelvis)

Dynamic measurements
- field use simulation
- data analysis via live-stream

Static measurements
- added pressure-mat
- manipulation of straps and buckles

RESULTS

Static calibration
- sensors work and read data
- sensor force range
  - chest 0-40 N
  - shoulders 10-120 N
  - pelvic 9-125 N

Dynamic measurements
- data analysis via live-stream worked

Static measurements
- results from plots coincide with results from the pressure mat

RESULTS OF THE STATIC MEASUREMENTS

Comparing the resulting forces (Fig. 3) and the plots from the pressure mat (Fig. 4, Fig. 5) in the lumbar region, the effect of the pelvic strap is visible.
Through opening the buckle, the pressure (kPa) detected in the mat decreases, the forces in the shoulder straps slightly increase.

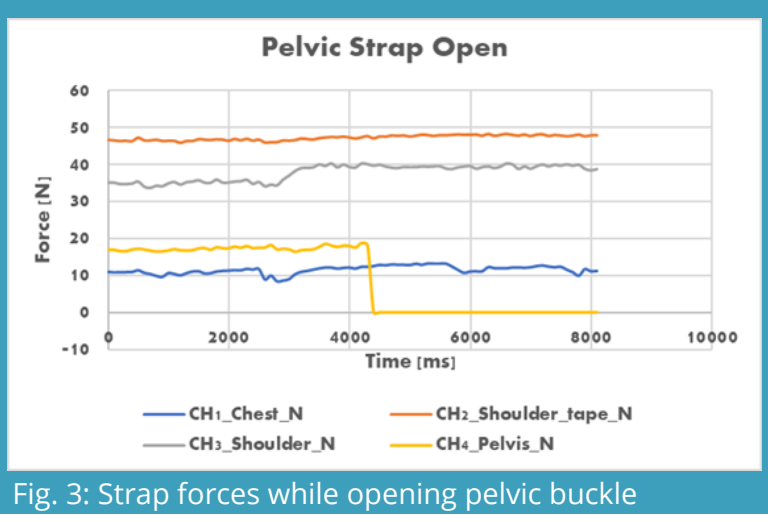


Fig. 3: Strap forces while opening pelvic buckle

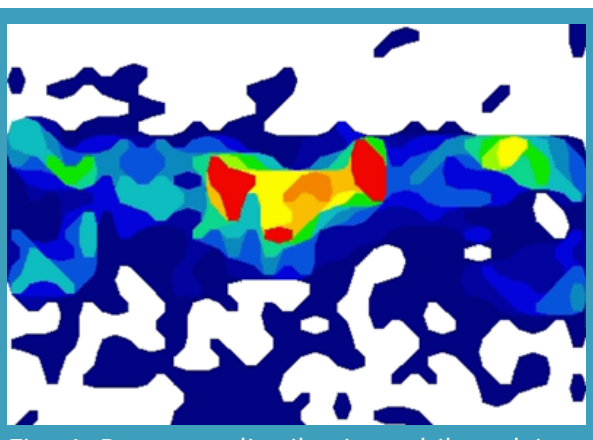


Fig. 4: Pressure distribution while pelvic buckle closed

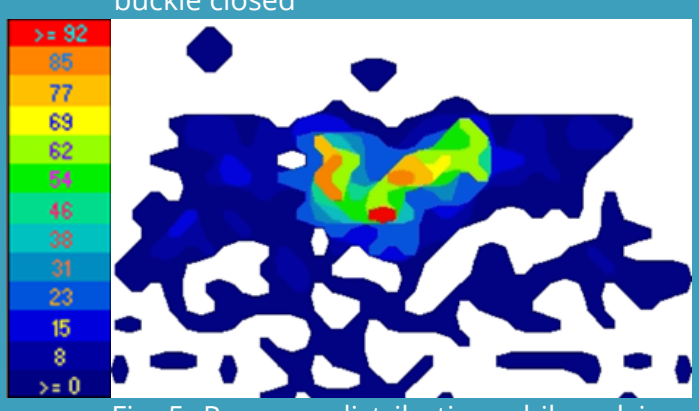


Fig. 5: Pressure distribution while pelvic buckle opened

DISCUSSION

PoC was achieved, the sensors read data in all situations. Further improvements would include the reengineering of the cell and the fixation brackets for more stiffness and stability. Additionally detachable plug-in cables might be added.

Supported by

A4SEE Alliance for Sports Engineering Education

VAUDE The Spirit of Mountain Sports

Team members:
Catherine Matje (st20m029@technikum-wien.at)
Anika Stöhr (anika.stoehr@s2018.tu-chemnitz.de)
Stephan-Anh Tran (st20m002@technikum-wien.at)
Alexandra Zenner (alexandra.zenner@mb.tu-chemnitz.de)
Supervision: Stefan Schwanitz (A4SEE), Frank I. Michel (VAUDE)

isea INTERNATIONAL SPORTS ENGINEERING ASSOCIATION